Appendix E
Rolling Gate Design Example

The opening for the closure in this example is 60 ft wide by 9.63 ft high.

Load Cases:

In accordance with EM 1110-2-2502, consideration shall be given to load cases I1 through I4.

Case I1, Design Flood Loading. Gate is closed; water on the unprotected side is at the design flood elevation; water is at or below the sill surface on the protected side. When skin plate is on the unprotected side, stability against flotation shall be checked. Design stresses shall not exceed 5/6 of the stresses allowed in AISC (1989).

Case I2, Maximum Flood Loading. Same as case I1 except that water level is to top of gate on unprotected side. Design stresses shall not exceed 1.11 times the stresses allowed in AISC (1989).

Case I3, Earthquake Loading. This case is applicable to support structures only.

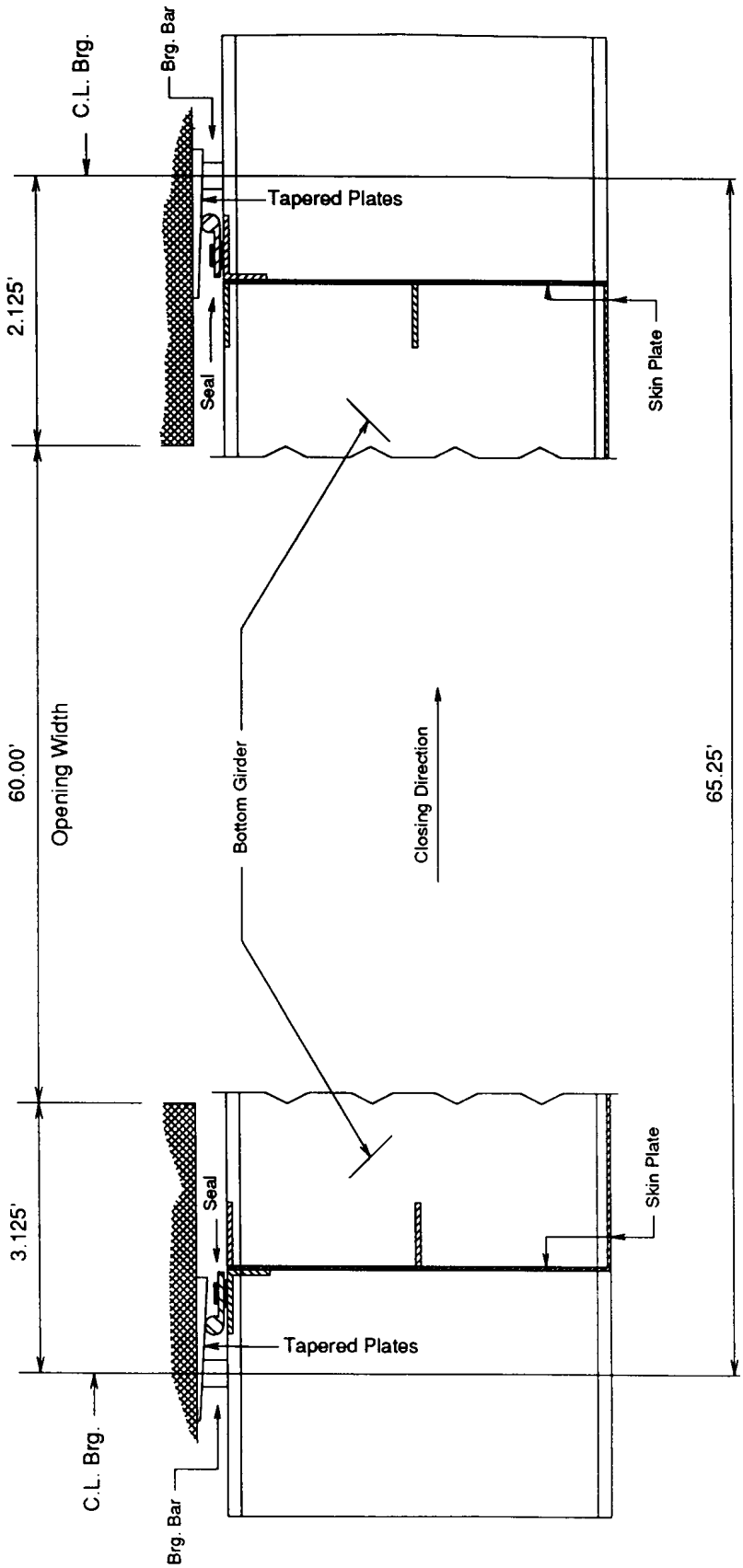
Case I4, Short-Duration Loading. Gate is in any position and is subjected to construction and/or wind loads. Design stresses shall not exceed 1.11 times the stresses allowed in AISC (1989).

In this example, cases I1 and I3 are not significant, and skin plate, intercostals, and girders are designed for case I2. Case I4 is applicable for design of latching devices and for checking overturning stability for wind loading.

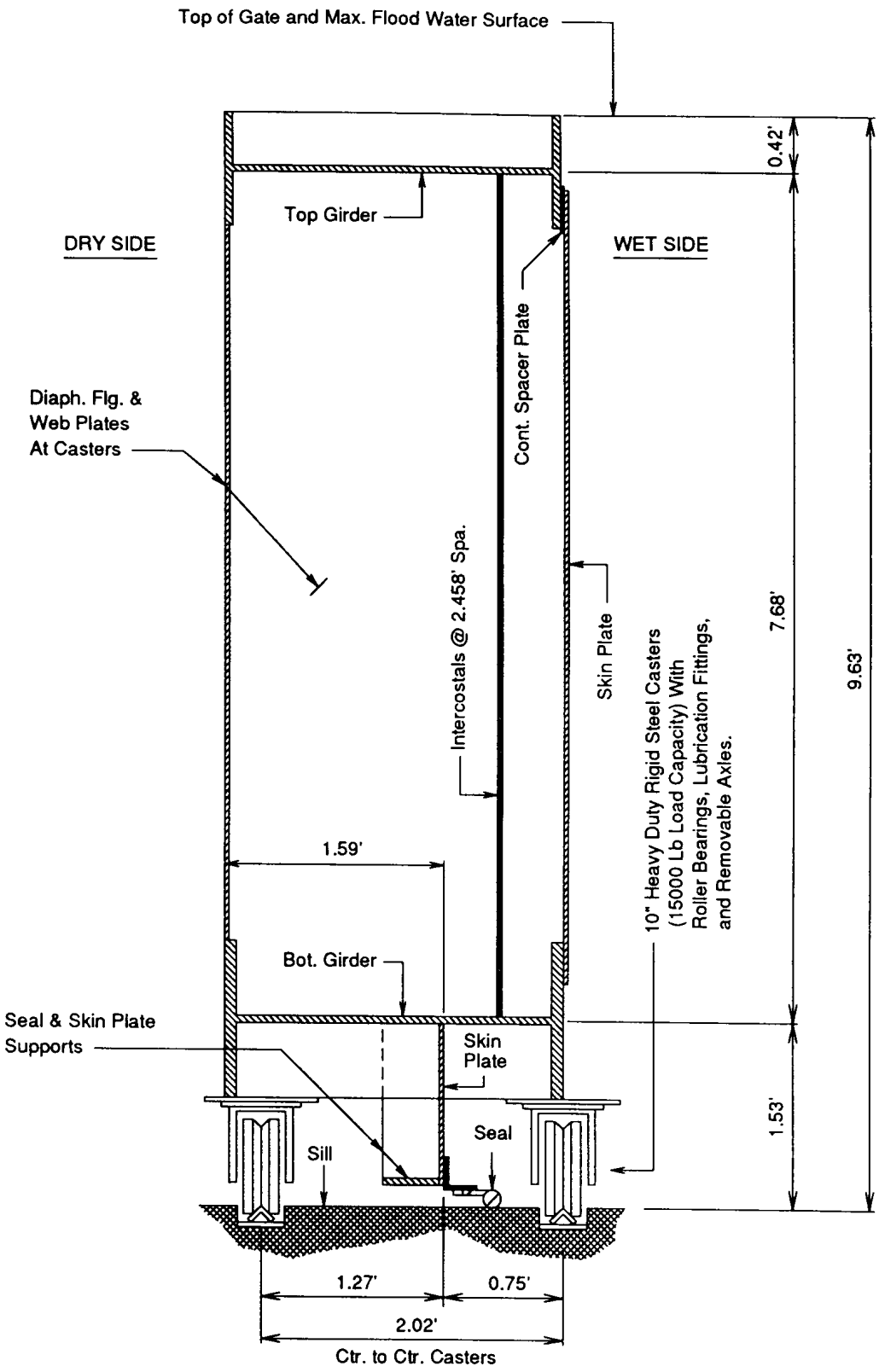
The skin plate is designed as a fixed end member spanning between intercostals. In order to ensure that the flat plate theory is applicable, deflection will be limited to 0.4 of plate thickness.

The intercostals are designed as simple beams spanning between girders.

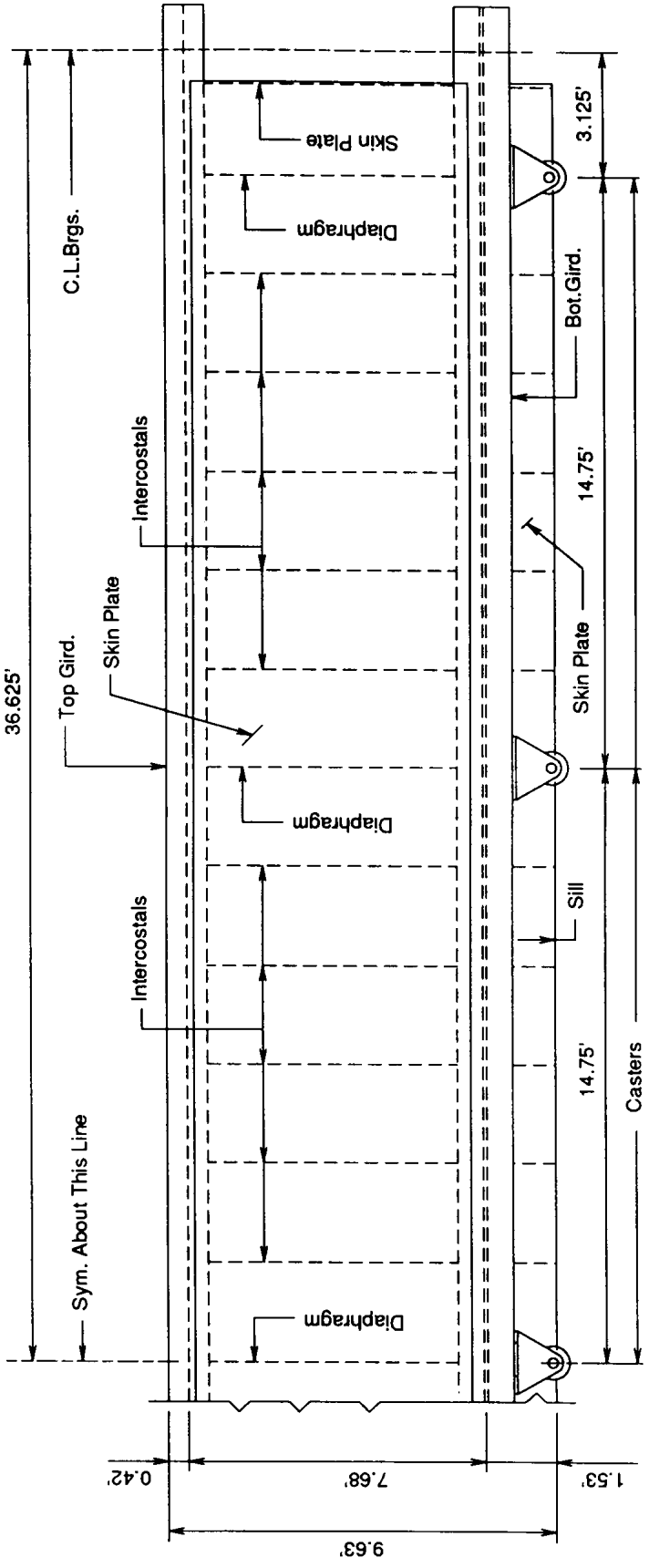
Girders are designed as simple beams spanning between bearing blocks on each side of the opening.



HORIZONTAL SECTION THRU GATE

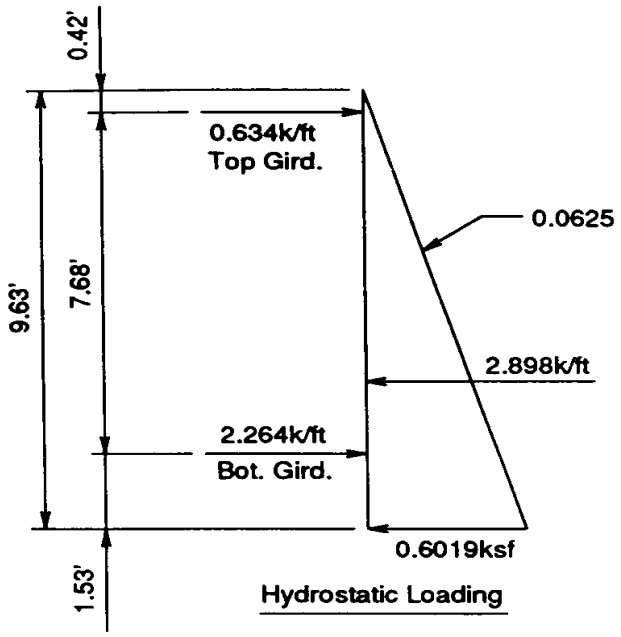


VERTICAL SECTION THRU GATE



1/2 WET SIDE ELEVATION

GIRDER DESIGN (Mat'l. ASTM A36)



Bottom Girder:

Trial Section W27x194

A=57, I=7820, S=556

W=2.264k/ft

L=65.25'

$M=WL^2/8=1204.89$k-ft

M=14458.68k-in

Since compression flange is braced continuously and compact section requirements of Table B5.1 of AISC (1989). are satisfied, the allowable bending stress is:

$F_b = 1.11(2/3)F_y = 26.67$ksi

$f_b = M/S = 14458.68/556 = 26.00\text{ksi} < F_b = 26.67\text{ksi}$

USE: W27x194 FOR BOTTOM GIRDER

Top Girder:

Trial Section W27x84, A=24.8, I=2850, S=213

$W=0.634$k/ft, L=65.25', $M=0.634(65.25)^2/8=337.41$k-ft

M=4048.94k-in

$f_b = M/S = 4048.94/213 = 19.01\text{ksi} < F_b = 26.67\text{ksi}$

USE: W27x84 FOR TOP GIRDER

SKIN PLATE DESIGN (Mat'l. ASTM A36)

p (6" above girder flg.) =0.0625(9.63-1.53-0.58-0.5)=0.439ksf

p =0.00305ksi, L=2.458'=29.5", $M=pL^2/12$=0.221k-in

$F_b = 1.11(0.75)F_y$ = 30ksi

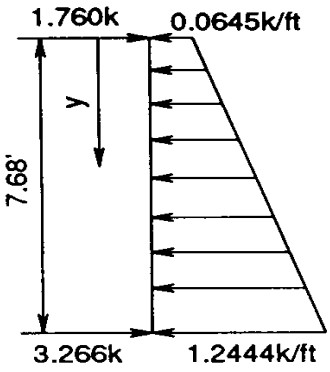
$t_{min\ for\ stress} = (6M/F_b)^{0.5} = (6x0.221/30.0)^{0.5} = \underline{0.2102"}$

$t_{min\ for\ defl} = (pL^4/12.8E)^{0.25}$

$t_{min\ for\ defl} = [0.00305(29.5)^4/(12.8x29000)]^{0.25} = \underline{0.2809"}$

USE 5/16" SKIN PLATE

INTERCOSTAL DESIGN (Mat'l. ASTM A36)



Hydrostatic Loading

$M_y = 1.76\,y - 0.03225\,y^2 - 0.025605\,y^3$

$V_y = 1.760 - 0.0645y - 0.0768y^2$

$V_y = 0$ and M_y is maximum at y=4.386'

M_{max} =4.939k-ft=59.27k-in

Trial Section WT7x13, S=3.31

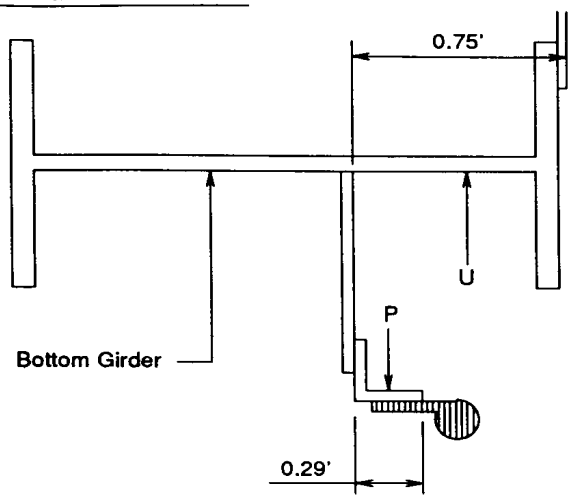
$f_b = M/S = 59.27/3.31 = 17.91$ksi

$F_b = 1.11(0.6)F_y$ =24ksi >17.91ksi

The WT7x13 is able to support the load without considering the contribution of the skin plate.

USE WT7x13 FOR INTERCOSTALS

CHECK RESISTANCE TO FLOTATION



U=0.75(0.0625)(8.16)=0.3825k/ft , W=Wt. of Gate=0.4200k/ft

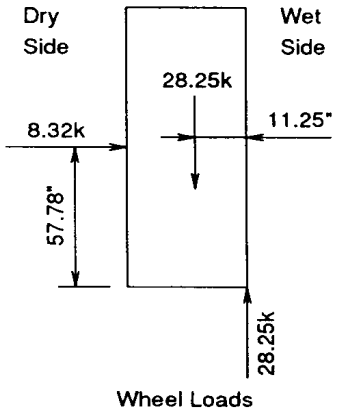
P=0.29(0.0625)(9.44)=0.1711k/ft , FS=Factor of Safety

FS=(W+P)/U=(0.4200+0.1711)/0.3825=1.55

Factor of Safety Req'd. by Ref. 3.a.(6). = 1.5

FS=1.55>1.5 o.k.

CHECK WIND LOAD STABILITY



Assume gate is closed, but unlatched, and subjected to a 75-MPH wind load.

Wind Pressure=$0.00256(75)^2$ =14.4psf

Wind Load=0.0144(60)(9.63)=8.32k

Gate Weight=28.25k

FS(overturn)=28.25x11.25/(8.32x57.78)

FS=0.66<1.00

Gate Must Be Latched To Withstand A 75-MPH Wind.

GATE MUST ALWAYS BE LATCHED WHEN IN CLOSED POSITION